INTESTINAL PERFORATION DURING THE COURSE OF TYPHOID FEVER, AND ITS SURGICAL ASPECTS.

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Frequency and Mortality of Perforation. While the percentage of deaths resulting from typhoid fever, and more particularly the proportion of these deaths due to perforation of the bowel is a well-established fact and quite generally known, we believe that the specific appreciation of the appalling number of these individual cases of perforation is by no means appreciated by the medical profession in general. While we all appreciate that the death rate from typhoid fever is from 7 to 14 per cent., averaging, probably, for the entire United States about 10 per cent., and that of these fully one-third are due to perforation, we think that few could have read without marked surprise the statistics recently collected by Dr. H. M. Taylor in an article on "Typhoid Perforation: Its Frequency, Prognosis, Diagnosis, and Treatment," *New York Medical Journal*, February 1, 1902, vol. lxxv. p. 193. From various statistical sources gathered in 1896 the author has determined the number of cases of typhoid fever in the United States as about 500,000 per annum, and the death rate about 50,000, which is doubtless a very fair average mortality. The frequency of perforation has been so definitely established from so many sources as being about 33⅓ per cent. of the deaths, that this number can hardly be questioned. This would give a death rate of something over 16,660 cases from perforation in typhoid fever in one year in the United States. Of this number it is now definitely known that 5000 to 8000 cases annually can be saved by operative interference. These figures represent, we believe, an adequate appreciation of the usefulness of surgical interference in the United States at the present time, and are certainly striking and instructive.

Owing to the very rapid medical and surgical progress along the lines of diagnosis and treatment in typhoid perforation during the last five years, the usefulness of operation in such cases has become established so far beyond the possibility of any doubt that it is no longer found necessary to urge and justify the procedure in the large majority of the cases. The question of recovery in such cases without operation is a matter of very grave doubt, although it has been absolutely known to occur in a few isolated instances where the damage was well localized near the cæcum, the cases assuming more the characteristics of appendicitis than those of perforation. It is an unwarrantable assumption, however, that unoperated cases recovering from mild or even marked symptoms of perforation are actual cases of recovery from perforation itself. At a time when medical treatment was practically the only means employed, the possibility of recovery was a very serious question even among the best authorities. In an article by Dr. R. H. Fitz (*Transactions of the Association of American Physicians*, 1891, vol. vi. p. 200) on "Intestinal Perforation in Typhoid Fever: Its Prognosis and Treatment," the author states: "Since perforation of the intestine in typhoid fever may take place without any subjective symptoms, and since suggestive—even so-called characteristic—symptoms may occur without any perforation having taken place, it must be admitted that recovery from such symptoms is no satisfactory evidence of recovery from perforation." Any practitioner who has been intimately associated with typhoid fever for any length of time has seen cases of typhoid suggesting perforation that have gone on to recovery, but too often there has been an unwarranted assumption that perforation actually occurred, and the instance has been mentioned as a remarkable cure. Since the usefulness of operation has been established in these cases it has become a well-known fact that the gravest symptoms of perforation may be present without the actual lesion, and, on the other hand, a rather premature assumption from vague symptoms has been absolutely justified by the discovery of perforation at operation. It is needless to say that these remarks apply to the diagnosis of perforation and not to the diagnosis of general peritonitis following perforation. The same position, however, the lack of signs and symptoms corresponding to the actual pathological condition, has been long since established with reference to general peritonitis that has recently been demonstrated with reference to typhoid perforation. The man who assumes an unassailable position in either one of the above-mentioned conditions in instances which cannot be subjected to actual demonstration, can no longer be considered to hold a tenable and justifiable position. It must be admitted at the present time that it is a far safer and much more justifiable assumption that the mortality in unoperated cases of intestinal perforation in typhoid fever is practically 100 per cent.

It was eighteen years ago that the first operation for perforation was performed. Dr. W. W. Keen, in 1898, in his book on *Surgical Complications and Sequelæ of Typhoid Fever*, published a table of 83 cases collected by Dr. T. S. Westcott, and in the *Journal of the American Medical Association* for January 20, 1900, in an article on "The Surgical Treatment of Perforation of the Bowel in Typhoid Fever," the same author gives a table of 75 additional cases collected by Dr. M. B. Tinker, 158 cases in all, which were considered to include all the cases published to January 1, 1900. Since that time the number of published cases has rapidly increased, but owing to greater familiarity with the subject and the increased frequency of operation it is believed that the number of published cases is far below the number of operations performed, especially in unsuccessful cases. The majority of the reports have been glaringly incomplete, indicating either a deplorable lack of scientific observation, or failure on the part of the writers to appreciate the increasing necessity for careful and detailed reports in such cases. The grosser and more evident facts with reference to diagnosis have already been well established, but the refinements in diagnosis which are going to make it possible to detect the occurrence of this complication at a much earlier stage and in a much larger proportion of the cases are still lacking. The question of general peritonitis ought not to enter at all into the consideration of perforation. Many of the pathognomonic signs, so-called, of perforation are now known to be merely an indication of general peritonitis. It is only by keeping these two conditions distinctly separated in the general medical mind that the diagnosis of perforation is to be more frequently and more accurately made, and it is only by strict and careful attention from now on to the refinements of diagnosis that we shall be saved the humiliation of operating for perforation and so frequently finding extensive peritoneal infection. Much improvement in operative technique at the present time cannot be expected, as this has already reached as advanced a stage of perfection as our present surgical knowledge will permit. Improvement is to be looked for almost entirely along the line of early and accurate diagnosis, which can only be the result of careful clinical observation, and what is of equal or even greater importance, of accurate pathological study. The pathology of these cases, especially the information afforded by extended post-mortem examinations in unsuccessful cases, has been even more neglected than the clinical study, whereas the whole question of prognosis and of the causes of death depend absolutely upon post-mortem findings. With but relatively few exceptions it has been assumed that the mortality following operation has been due to general peritonitis. It cannot be denied at the present time that this is not for the most part a correct view, but the comparatively few post-mortem examinations recorded certainly indicate that a good many of the unsuccessful cases die from causes entirely independent of the operation, and which at the present time are beyond means of control. It is in the hope of stimulating interest in the more uncertain points of diagnosis, and especially in the pathological knowledge of these cases, as well as affording some definite suggestions for accomplishing these objects, that the present article is presented. Many of the observations contained in this paper have been suggested by cases of typhoid perforation studied at the Lakeside Hospital in Cleveland during the last four years, several of which were reported by the writer from the surgical clinic of the hospital in The American Journal of the Medical Sciences, January, 1902, vol. cxxiii. p. 38, "Laparotomy for Perforation in Typhoid Fever."

It may seem at first that it requires considerable temerity to speak of the diagnosis of typhoid perforation from a purely surgical standpoint. The view of the medical profession, however, has changed so radically with reference to the treatment of perforation, that it may almost be said to come under the head of a surgical rather than a medical complication, in the same manner in which appendicitis is now brought to the observation of the surgeon, not solely at a time when operation is immediately demanded, but for the sake of diagnosis in doubtful or somewhat obscure conditions. Surgical aid in the diagnosis of appendicitis has become of the utmost value, and we feel equally certain that much the same consideration will prevail with reference to typhoid perforation. It is largely on this account that the surgical interest in typhoid fever in general has recently become so manifest. The physical conditions of the abdomen are often so altered during the course of typhoid fever that the surgeon who is unfamiliar with the typhoidal abdomen is utterly incapable of giving a well-considered opinion in cases of suspected perforation. It was in view of this fact that Dr. Osler, a few years ago, so strongly urged the desirability of surgical observation of the typhoid cases at the Johns Hopkins Hospital, and it is largely on account of the lack of opportunity for such observation among surgeons in general that so little has been done on the subject outside of large hospitals. The desirability of surgical familiarity with the abdominal conditions in all stages of typhoid fever cannot be too strongly urged, and its importance cannot be over-estimated.

Etiological Considerations. In considering the subject of intestinal perforation in typhoid fever, there are a number of points in the etiology of the condition which have already been determined with all the accuracy that is desirable, and which can be dispensed with in a few words. The *time at which the perforation occurs,* so far as diagnosis is concerned, is of no consequence. It most frequently occurs during the third week, but in one of the Lakeside series there were very marked suggestions of perforation in one case on the fifth day of the disease, although no perforation was found, and in another case general peritonitis had followed a perforation occurring on the sixth day, as nearly as could be made out from the history. It may occur late in a prolonged convalescence, or in a relapse, so that from a standpoint of diagnosis the stage at which the patient has arrived in the illness must be entirely overlooked. The time of perforation is of much consequence, however, with reference to the general condition of the patient and to the way in which operation is borne, as will be mentioned later. The *severity of the fever* can be overlooked entirely in diagnosis, except for the fact that diagnosis is more difficult in severely sick cases, where one scarcely ever finds the indications so marked. It is the opinion of Dr. Osler that it occurs more frequently in severe cases; but medical opinion in general is quite divided, and from the study of the reported cases one is certainly justified in a conservative opinion. It certainly appears to occur about as frequently in mild as in severe cases, and in any event it occurs so frequently in both classes that the mildness or severity of the disease can be entirely laid aside with reference to diagnosis. The matter of *constipation and diarrhœa* is of little consequence in diagnosis, the cases being so equally divided that these conditions can also be overlooked. The question of *age and sex* is of slightly more importance, but this also can be overlooked almost entirely. It occurs much more frequently in young adults, but three or four cases have been reported in children under fifteen years. It also occurs much more frequently in males than in females. Neither of these conditions can influence the diagnosis to any appreciable degree, however, except that one might be justified in delaying a little longer in cases of young children. It is of somewhat curious interest that only two instances of operation for perforation in a negro have been reported, and that in only one of these was perforation actually found. The question of *intestinal hemorrhage* is of somewhat more importance, but mainly from the fact that its occurrence at the time is very apt to mask or simulate perforation and render diagnosis much more difficult. As an etiological feature, however, antecedent to perforation, we believe it can be entirely overlooked. The occurrence of hemorrhage is purely fortuitous, and depends solely upon the chance of the ulcerating surface encroaching upon a vessel of considerable size. It cannot be assumed that the ulcer is approaching the peritoneal surface more rapidly on that account, or that the process will even eventuate in perforation merely because the hemorrhage has occurred. A comparatively small number of the reported cases of perforation have been preceded by hemorrhage, and it is only a small percentage of the cases of hemorrhage that have eventuated in perforation. In instances where the relation is suggested it is almost invariably a mere assumption that hemorrhage has come from the particular ulceration that has gone on to perforation. So that in considering the diagnosis of perforation we think one can entirely overlook as etiological factors the period of the disease in which the perforation occurs, the severity of the disease, the occurrence of constipation or diarrhœa, the question of age, sex, and color, and the occurrence of hemorrhage from its purely etiological standpoint.

SYMPTOMS AND SIGNS OF PERFORATION. In considering the *symptoms and signs* of perforation we believe it is of the utmost importance *to preserve a sharp distinction between the two.* Some of the signs of perforation are doubtless always present, although possibly unobserved or misinterpreted. The amount of dependence one can place on symptoms, however, depends entirely upon the mental condition of the patient and his appreciation of sensations. The patient whose faculties are moderately alert can afford very material aid through his perception of pain and his own conception of being very much worse or very much better. In proportion to the amount of apathy so often present to a greater or less degree, these sensations are much less acute, and the patient's ideas regarding himself are of much less consequence. In deeply apathetic or delirious cases the question of symptoms must almost invariably be largely or entirely set aside. Consequently in the latter class of cases, which are almost always the severely sick cases, one must rely almost entirely upon physical signs and phenomena. As in so many other conditions, in the cases in which one is most desirous of making an early and careful diagnosis, the means at hand for making this diagnosis are much more strictly limited than in less severe cases where one can risk a little larger margin of error. It is thus evident that in most severe cases one is forced to be more radical in his diagnosis and establish the presumption of perforation on somewhat less sufficient grounds. These two distinctions, then, between signs and symptoms on the one hand, and the clear-minded as against the apathetic and delirious patients on the other, at once assume proportions of the very highest importance, and it does not seem to the writer that these considerations can be too strongly urged. These are distinctions to which we feel justified in making frequent reference.

Symptoms. In considering first the symptoms of perforation one finds for consideration pain, sensitiveness, the sensations associated with systemic shock, and the sensations of altered respiration. These have been named in the order of their relative importance in the vast majority of cases in which the sensibility of the patient is sufficiently acute to make them of any use whatsoever.

Abdominal pain is by far the most important symptom, and if present demands the utmost consideration in forming a diagnosis. This is especially true where the patient has been comparatively free from previous abdominal complications and the symptom appears as a sudden, sharp, often agonizing sensation, quite circumscribed, located in the lower part of the abdomen near the median line or toward the right side; and especially if the pain remains severe and circumscribed for an hour or more. Such a picture one can scarcely mistake, and with a very slight suggestion along the line of physical signs one must feel justified in making the diagnosis. The pain, however, may come on gradually, commencing almost anywhere in the abdomen, but more frequently starting near the median line, near or below the umbilicus.

If the pain is general at the start it usually becomes more closely confined to the lower half of the abdomen within a short time. When pain becomes more general after having been moderately well localized at the start, it suggests rather strongly that peritoneal infection is progressing from a point of perforation. The pain, whether sudden or general in its first manifestations, localized or diffuse, may at the same time be either moderate or severe; in general it can be said that the better localized the pain the more keenly it is appreciated, but the distinction is of vastly less consequence than the fact itself that pain is present. So that the occurrence of pain is a feature of the utmost importance when present. The location of the pain, its limits, its severity, the manner of appearance, and persistence are matters of secondary importance, except possibly the last-mentioned feature. In proportion to the degree to which these various features of the pain are accentuated these secondary considerations of pain may be said to be of importance, but the absence of such accentuation must be almost entirely overlooked in arriving at a diagnosis.

Sensitiveness is, of course, very closely allied to pain, and may almost be considered as a less strongly marked manifestation of the same sensation, so that many of the things mentioned with reference to pain are true to a less degree with reference to sensitiveness. All patients with abdominal pain are sensitive; but one is often obliged to rely considerably upon sensitiveness as a symptom in the absence of pain. The limits of sensitiveness are usually more narrow than those of pain, and on this account it is sometimes of aid in assisting the patient to more definitely locate his pain. Localized pain is accompanied by localized sensitiveness, but diffuse pain is not infrequently associated with circumscribed sensitiveness, and this fact is often an aid of considerable importance. Spreading sensitiveness is open to the same interpretation as spreading pain, and is if anything a little more to be relied upon. The occurrence of sensitiveness is more common to the lower half of the abdomen or to the entire right half. Its frequent occurrence in the right lower quadrant, to which attention has been strongly called by several writers, does not appear to exist in many cases. The truth of this statement has been strongly suggested by the Lakeside series and seems to be justified by the large proportion of reported cases. The degree of accentuation increases the usefulness of sensitiveness, also, as a symptom, possibly a trifle more so than in cases of pain; but here again the characterizing features of sensitiveness are of only secondary importance as compared with the presence of sensitiveness itself.

The *sensations associated with systemic shock* vary so greatly in different patients, and are so closely allied to certain signs to be mentioned later, that one is obliged to speak of them in a very general way. These sensations, general and varying as they are, however, in a responsive and clear-minded patient are worthy of careful consideration when present. Perhaps their meaning is best described by the expression so often used by the patient himself, literally or implied, of an "all-gone feeling," as if the "bottom had dropped out of him;" a feeling vaguely described but strikingly realistic, that some serious catastrophe has occurred. It is doubtless this that sometimes causes in these patients the intensely anxious and apprehensive countenance not infrequently seen, the exact meaning of which they are unable to put into words. It is scarcely possible to speak of these sensations in more detail. Their presence is unmistakable and of considerable importance; their absence, again, may be entirely disregarded in making a diagnosis.

The *sensations of altered respiration* are of little consequence compared with the other symptoms mentioned, or compared with respiration as a sign. The patient is apt to feel short of breath, and finds that his respirations for some reason or other must be largely costal. As a sensation it is present in almost direct proportion to the intensified characteristics of pain already mentioned, and in the absence of pain, at least in the absence of pain and sensitiveness, it does not exist. The symptoms of altered respiration are of so little consequence that they may be entirely disregarded.

Signs. But it is upon the signs suggesting perforation that one is forced to rely largely, and in apathetic and delirious cases one must rest his diagnosis upon these signs almost absolutely. Here, however, it is necessary to draw the distinction even closer between perforation and general peritonitis, and keep in mind that the diagnosis of general peritonitis is not the diagnosis of perforation. And against maintaining this distinction one cannot with propriety set the fact that both these conditions at times are very bizarre and misleading in their manifestations, and that occasionally the postmortem examination reveals a condition of which the manifestations before death gave absolutely no recognizable indication. These signs suggesting perforation include, first, indications gathered from the abdominal examination alone, such as muscular resistance, the presence of gas within or outside of the intestine; and, second, certain general systemic indications, such as vomiting, altered respiration, temperature, pulse, altered blood conditions, and general systemic shock.

Muscular resistance is, we believe, the most important of all these signs. It is a sign of the utmost importance in almost any acute intra-abdominal condition, and its reliability can rarely be questioned with impunity. It indicates very clearly that the abdomen is trying to protect itself against injury from the outside, and is a condition largely independent of the volition of the patient. The presence of pain and sensitiveness is, to be sure, usually associated with muscular resistance to a greater or less degree, but the same patient, if he is deeply apathetic or delirious, and abdominal protection is still needed, would show muscular resistance. This muscular resistance is not infrequently general, but in cases of perforation in typhoid fever, since the lesion is almost invariably located in the lower half of the abdomen or on the right side, the resistance is accentuated in these localities. Its usefulness is impaired to an inexperienced observer, however, in that many cases of uncomplicated typhoid show a varying amount of muscular resistance which must not be mistaken by one seeing the case for the first time. Here, again, is a very striking example of the necessity for surgical familiarity with the abdominal conditions in uncomplicated typhoid, and also of the great desirability of having typhoid cases under frequent surgical observation. Muscular resistance is probably never absent in perforation. If resistance was present before perforation it is probably always increased, and in such cases an accurate estimation of the degree of increased resistance is of great value.

Distention and tympany from gas within the intestines are signs of no consequence with reference to perforation *per se.* Their absence is of equal inconsequence. As signs of spreading peritoneal infection, however, they are both of well-known and merited consequence and need not be discussed here. They are confirmatory evidences only in so far as one has been willing to run the risk of spreading infection secondary to the perforation. If there was gas in the intestines previous to perforation, as is frequently the case, it would not be increased by the accident; if the abdomen was soft and there was no distention one would not find a sudden accumulation of gas when perforation occurred. So that aside from the fact that distention and tympany may tend to obscure the diagnosis and render it more difficult they can both be set aside entirely with reference to the diagnosis of perforation itself, and are confirmatory only in proportion to the degree of spreading infection.

The presence of *abdominal gas outside the intestine,* however, if its presence can be demonstrated with certainty, is practically a proof of perforation. Such evidence is usually sought through obliteration of the liver dulness. This manifestation, however, is a matter of such uncertainty that it renders the interpretation of the sign of practically no value. The obliteration of liver dulness has been demonstrated again and again to be due to a distended colon or small intestine as well as to free abdominal gas, and in several cases in which diagnosis was considered practicaly absolute on account of this sign, no perforation was found. The absence of altered liver dulness is, of course, a matter of absolutely no consequence in diagnosis, and in cases where the liver dulness is altered to an appreciable extent, it is quite impossible to say whether it has been effected by free abdominal gas or distended intestine. If the liver dulness is altered one may be justified in being suspicious of the circumstance, but we feel he is unjustified in any further assumption.

Nausea and vomiting occur so infrequently that they are of little aid in the diagnosis, and their absence may be entirely set aside. They are more frequently associated with cases in which there is severe pain, and in these cases are probably open to the same interpretation as nausea and vomiting under any condition of severe abdominal pain. They are also seen, however, as manifestations of severe systemic shock, but in such cases the presence of shock is so manifest that one need not look for the confirmatory evidence of vomiting. They occur in less than 25 per cent. of the cases. Their presence is of slightly confirmatory value only.

Altered respiration is a sign of consequence, and is probably to be interpreted as muscular resistance, namely, a means of protecting the abdomen. The prevailing type of respiration where perforation has occurred is almost invariably distinctly thoracic. This type of respiration is also seen in severe cases of typhoid with distention and rigidity, but the phenomenon is considerably accentuated when perforation occurs. It was a very striking sign in all the Lakeside cases. It is rather more evident, to be sure, in clear-minded patients with considerable pain, assuming somewhat the quality of a symptom; but it is sufficiently recognizable as a sign alone where the mental condition of the patient is to be entirely disregarded. The rate of respiration, also, is nearly always more or less increased, but is of largely secondary consequence. If the patient is in pain, respiration may be unduly increased on this account alone; if he is insensible to pain, the restricted respiratory excursion will necessitate somewhat more rapid breathing. Altered respiration, then, of the costal type warrants much the same assumption as muscular abdominal resistance, and we believe this alteration can be found in practically all cases if sufficiently well observed. As this alteration is largely relative it is probably less reliable than muscular resistance, and as it is open to the same interpretation its practical value, aside from being merely confirmatory, is not great. Its absence, however, as in the case of muscular resistance, must be considered of considerable importance.

Alteration in temperature may be of some positive value, but the absence of such alteration must be set aside entirely in making a diagnosis. An accompanying chill is of rather infrequent occurrence. Two of the Lakeside cases showed no alteration in temperature, and many other reported cases are equally negative in this respect. Many cases will show a rise or fall generally not exceeding 2° F., which, when considered with the usual irregularity of the typhoid chart, must be admitted to be of little value. A very decided drop in temperature, as is sometimes seen in hemorrhage, is rather less frequently met with in perforation, we believe, than has been generally supposed. As an indication of spreading infection the value of altered temperature has long since been well established, as was mentioned also with reference to distention and tympany; but as an indication of perforation itself the matter of altered temperature may be very largely overlooked.

The *pulse* is an indication of greatest importance. It is, of course, an evidence of systemic shock accompanying perforation, but is a matter of such consequence that it deserves special mention. One can almost invariably expect a rise in pulse that is quite marked, perhaps twenty beats or more, the alteration occurring rather suddenly. This rise in pulse is affected in a measure by the increased respiration, but is almost always too marked to be accounted for entirely on such grounds. The quality of the pulse also is markedly altered, the tension being reduced, and the pulse rendered readily compressible. These strikingly distinctive changes in the rate and quality of the pulse are, of course, less strongly marked in more severely ill cases, in which the pulse is already rapid and the quality poor, but even in such cases, to one familiar with the daily condition of the patient in question, the relative alteration is evident. It may also be of some aid in differentiating between shock and hemorrhage, as alteration in rate and quality is likely to be more gradual in hemorrhage; it is a distinction, however, that is by no means always recognizable, but may serve as a somewhat confirmatory observation. Sudden marked alteration in rate and quality, then, is an indication of great importance.

Definite knowledge regarding *altered blood conditions* occurring in typhoid fever is so meagre that we feel that little reliance can be placed upon it in making a diagnosis of perforation. This may appear at first sight to be a rather striking and radical statement. In the large proportion of cases it is very doubtful if *the white blood count* is affected by the perforation itself. It is true that in many instances a leucocytosis is observed to follow perforation at an interval of anywhere from one to six hours; but, on the other hand, in a very considerable number of cases no such leucocytosis is observed. It has also been observed that moderately sudden and quite extreme leucocytosis occurs in patients in whom perforation was supposed to exist, when operation showed definitely that none had occurred. One of the Lakeside cases showed such a rise from approximately 8000 to 50,000. It has been assumed by some and considered demonstrated by others that following perforation there is a "wave of leucocytosis" extending over a period of a few hours, and that in cases where no leucocytosis is observed the observation has been made at the close of this wave. Some cases show this condition, others do not. Whatever one's belief regarding it may be, it is known to be a certainty that the leucocytic equilibrium in man is very easily disturbed to a greater or less extent. Some of the causes that at times effect this disturbance are known with a moderate degree of certainty, but the number of causes with which we are somewhat acquainted is probably very small as compared with the number of causes for which we are utterly unable to afford any adequate explanation at the present time. Slight temporary differences in the white blood count are usually beyond explanation, and while it may be assured that such temporary flights occur in perforation it is an assumption that must be based upon far wider and much more accurate observation than has been made thus far. These waves of leucocytosis have been demonstrated to exist in many conditions, and for that matter in supposedly normal individuals, which had they occurred in conjunction with symptoms suggesting perforation might be assumed to be due to that cause. One such set of observations has been made by Cabot, Blake, and Hubbard in an article on "A Study of the Blood and Its Relation to Surgical Diagnosis," *Annals of Surgery*, vol. xxxiv. p. 361. These views are based upon the observation of only ten cases, to be sure, four of which were typhoid fever, but they are as extended and certainly more accurate on the whole than any observations in favor of the leucocytic wave theory in perforation, and serve to put the subject where one is unable to attach to it much diagnostic importance at the present time. What may, however, prove to be of some consequence is a steadily increasing leucocytosis reaching a well-marked maximum, which is attained after a considerably longer period than the height of the so-called wave. The interpretation of this increase, however, is largely an assumption; it may be due to spreading infection which has not yet become sufficiently marked to cause the fall in the number of leucocytes not infrequently seen in cases of extensive peritoneal infection. Be this as it may, it must be admitted to be of relatively small practical importance, for if these cases are to be saved one must not wait for a well-developed leucocytosis from any such cause. There is a great though apparently decreasing tendency to overestimate the value of leucocytosis in surgical abdominal conditions at the present time, and we feel that this is an example. The irregularity noted in the blood examinations in cases of demonstrated typhoid perforation is so great that the subject needs far wider and much more accurate study than has thus far been given. But while from the standpoint of diagnosis the question of leucocytosis must be largely set aside, from the standpoint of careful and complete observation of cases the importance of such examination cannot be overestimated. The subject may have possibilities; before leaving it the absence of such possibilities must be thoroughly demonstrated.

Alteration in the amount of *hæmoglobin* and the number of *red blood corpuscles* in these cases is a matter that has been almost entirely overlooked, but from a theoretical standpoint it would appear to be of somewhat more consequence than the white count. The most difficult cases for diagnosis are those in which the decision lies between hemorrhage and perforation. If the diagnosis of hemorrhage is incorrectly made, and instead of this perforation has occurred, the desirable opportunity for operation is lost while waiting for the demonstration of hemorrhage through the bowel discharges. It may be possible to make use of the red count and the estimation of hæmoglobin as affected by hemorrhage to aid in the differential diagnosis in these cases. The white count can be of little aid in this differentiation. It is felt that some careful observations along this line will prove valuable.

Systemic shock is probably always present, although not always recognized, and is an indication of the very greatest importance. The condition is usually so evident and its indications so readily recognizable that it is scarcely necessary to consider it in detail other than to insist on its importance. Altered respiration to a slight degree possibly, and especially alterations in pulse, temperature, and blood are indications of general systemic change. The pallid countenance, the drawn facial expression, slight cyanosis of lips and finger-nails, the sudden occurrence of perspiration, and the slight tremor that is sometimes present, together with the altered pulse and temperature, make a very striking picture when well marked. Here, again, however, in proportion as the organism is deeply affected by the disease itself, the margin of vitality susceptible to even the severest degree of shock is narrow, and the system may be so deeply affected that it fails entirely to respond in any appreciable degree to the shock received, and the catastrophy passes unrecognized. It must be kept in mind, however, that this is said solely with reference to the severity of the infection, and is entirely independent of the mental condition of the patient. Shock is distinctly recognized by physical, not mental demonstrations, and if any reactionary power remains in the organism the condition can be recognized in spite of delirium or apathy. This condition of systemic shock was observed in all of the Lakeside cases. In one case with severe infection and moderately well-marked shock no perforation was found, and the cause of the suddenly altered condition was never demonstrated.

In summary, then, the signs and symptoms upon which one is forced at the present time to rely mainly in making a diagnosis of perforation are *pain, sensitiveness, muscular resistance, altered respiration, alteration in rate and quality of the pulse, and evidences of systemic shock.*

DIFFERENTIAL DIAGNOSIS. The question of differential diagnosis is a matter upon which there is little to be said with satisfaction, owing largely to our fragmentary and quite indefinite knowledge of the causes of pain during the course of typhoid fever. Pain must be considered a most important symptom, and at times the most important feature in making the diagnosis of perforation, but at the same time it is the indication which most often leads us astray. A most instructive and commendable paper by Dr. Thomas McCrae, "Abdominal Pain in Typhoid Fever," *New York Medical Journal,* May 4, 1901, vol. lxxiii. p. 749, is perhaps the most valuable article of its kind that has occurred in the more recent literature. His report is based upon the analysis of 500 cases at the Johns Hopkins Hospital, in which it was found that only two-fifths of the patients were free from pain or tenderness; one-fifth showed tenderness only, while two-fifths showed pain sometime during the attack. Of this number there were only 13 cases of perforation, while in 70 cases there was no discoverable cause. It must be admitted that in a large proportion of cases in which the existence of perforation has not been demonstrated at operation, the causes of the indications leading to the diagnosis have not been discovered, and in instances in which the causes have been assigned it was largely an assumption. Among these causes, known or supposed, are diaphragmatic pleurisy, pneumonia, iliac thrombosis, appendicitis, peritonitis from undiscoverable causes, intestinal obstruction, suppurating mesenteric or retroperitoneal glands, cholecystitis, and intestinal hemorrhage.

Regarding *pleurisy* and *pneumonia,* they have both been known to be associated with abdominal pain, the entire aspect of the case resembling very closely that of perforation. If the pneumonic process is not sufficiently near the surface to be recognizable, one can have little hope of avoiding the mistake. A careful pulmonary examination in all cases is the only possible precaution. Such cases are, however, fortunately, very rare. *Iliac thrombosis* is usually associated with sensitiveness in the groin and for a varying distance along the course of the femoral vein, and a careful examination may reveal this cause of a misleading symptom and should always be carefully kept in mind. *Appendicitis* occurring during the course of typhoid fever can very rarely be differentiated from perforation occurring in or near the cæcum, and there is fortunately no need for so doing, as the indications for operative interference are so nearly identical. *Peritonitis* without discoverable cause has been mistaken for perforation, but can scarcely give the early appearances of perforation; in either event, however, immediate interference would be indicated. *Intestinal obstruction* has simulated perforation, but here, too, the instances in which it would simulate the early symptoms of perforation must be extremely rare, while the indications for exploration would be equally certain. The considerations of consequence in connection with appendicitis, peritonitis, and obstruction with reference to perforation are not so much in relation to the difference in diagnosis, but that the conditions must be kept in mind as possible causes of the symptoms and signs in cases in which no perforation has been found. The same may be said of cases of *suppurating mesenteric or retroperitoneal glands;* this condition can scarcely be mistaken for perforation pure and simple, but has been mistaken for resultant indications of perforation due to spreading infection. *Cholecystitis* has simulated perforation very closely, as in the case reported by Dr. H. B. Allyn, "Typhoid Fever, with Perforation of the Colon and Gall-bladder; Operation; Death; Autopsy," *Philadelphia Medical Journal,* August 3, 1901, vol. viii. p. 193. In this case no perforation was found, the existence of cholecystitis was not discovered at the operation, and the cause of the misleading indications was found only at autopsy. In such cases, however, the pain is usually high in the abdomen, and is very likely to be associated with slight jaundice or a trace of bile in the urine. Here, again, however, the important consideration is not the diagnosis, but the possibility of overlooking such a condition where no perforation is found. From *hemorrhage,* however, differential diagnosis is of the utmost importance. Less than half of the cases of hemorrhage are associated with pain, and it is probably the proportion is small in which perforation might be reasonably suspected. The diagnosis is of importance not so much because hemorrhage sometimes suggests perforation, but because the indications of perforation itself are sometimes attributed to hemorrhage, which is a mistake of the utmost gravity. Where the two conditions do suggest each other it is a diagnosis of the greatest difficulty, and in the present state of our knowledge there is relatively little to aid one. The pain and sensitiveness may be the same, the signs themselves may be almost identical. Alteration in the rate and quality of the pulse, however, may be more gradual in hemorrhage, but the difference is purely relative and not always of assistance. The evidences of systemic shock are usually more severe in perforation, but this is also a relative difference and merely a suggestion. As the case progresses the diagnosis of hemorrhage is usually rendered clear by the subsequent appearance of blood in the stools, but if perforation is strongly suspected one cannot be justified in delaying for this confirmation of the diagnosis of hemorrhage. The reduction of hæmoglobin and the number of red corpuscles, it is strongly believed, may be of material aid in differentiating these two conditions, as has been suggested by McCrae, and was of demonstrated value in one case at the Johns Hopkins Hospital. We feel that this is a most important subject, and would urge that it be widely investigated and reported for the sake of accumulated statistics. But when all is said it must be admitted that differential diagnosis between perforation and hemorrhage is sometimes extremely difficult and misleading, and in such instances one must feel justified in diagnosing perforation rather than hemorrhage, since the gravity of delay in perforation far exceeds that of exploration.

It may be well to mention here several things not already noted which may obscure or aid in the diagnosis. To one who is familiar with the not infrequent effects of tub baths, especially in severely ill cases, it would be suggested at once that the abdominal pain, muscular rigidity, and varying degrees of systemic shock sustained might lead one astray in a case where perforation was suspected or even where no such thought had been entertained previously, if the effects of tubbing were unusually marked. It is, therefore, a wise precaution in suspected cases to substitute sponge baths, in order that the diagnosis may not be obscured by ever so slight an alteration in the patient's condition from other than the suspected cause. In one of the Lakeside cases the sudden change in the patient's condition was thought to be due to the effects of the tubbing, and caused a disastrous eight-hour delay before operation. Again, in administering morphine in cases of hemorrhage one is courting danger on one hand while attempting to forestall it on the other. It is at once evident that in cases suggesting both perforation and hemorrhage the diagnosis should be clearly defined if possible before administering morphine. There are occasionally cases, however, in which one feels obliged to give morphine regardless of the consequences. One other suggestion which we have not seen mentioned elsewhere seemed at the time to be of material aid in the diagnosis in two of the Lakeside cases, in one of which perforation had actually occurred, while in the other operation was delayed and the case recovered. In both of these instances the question was raised whether the rather moderate abdominal pain might not be due to flatus. A small glycerin enema administered in each instance was expelled by both patients with the evacuation of considerable gas. In the case of actual perforation no relief from the pain was experienced, while in the case recovering without operation the pain was considerably though not entirely relieved. It is a procedure that is scarcely applicable in cases of suspected hemorrhage, but may occasionally afford information of more or less value where perforation is suspected independently of hemorrhage.

It may be permissible to consider in this connection the so-called "pre-perforative stage," upon the existence of which as an absolutely recognizable condition Dr. Cushing, of Baltimore, has been so persistently insistent. In the *Johns Hopkins Hospital Bulletin*, November, 1898, No. 92, p. 267, he defines his position as follows: "Under the 'pre-perforative' stage let it be understood that the whole period is included between the first involvement of the serosa with the customary formation of adhesions at this point, until these adhesions, which may for the time constitute the floor of the ulcer after the serosa has given way, have themselves become broken down and general extravasation has taken place." What he refers to is a pre-extravasation and not a pre-perforative stage, and this distinction the writer himself mentions in a subsequent paper. That adhesions form in all cases of perforation is probable in spite of the fact that they cannot always be demonstrated at operation. That every case of perforation has what may be called a pre-perforative or pre-extravasation stage is too evident to need mention, just as anything that occurs has a pre-existent condition; but when the same writer mentions it as a " definite recognizable condition" he is insisting on a refinement of abdominal diagnosis that is quite beyond the possibility of recognition with any degree of certainty. The impossibility at the present time of recognizing a distinction depending upon the thickness of the peritoneum is self-evident. An early diagnosis is the *ne plus ultra* in perforation, and doubtless in some of these cases one may feel satisfied he has found the condition mentioned by Dr. Cushing, but it is seldom to be hoped that one will strike the exact time of perforation with such accuracy. It is firmly believed that the best that can possibly be hoped for is the possibility of operating upon these cases within a considerably wider limit than Dr. Cushing urges, a little before or a little after the catastrophe has actually occurred, and the cases in which one is able to place his operation between the involvement of the peritoneum and actual extravasation are, we believe, purely fortuitous and not a matter of judgment.

OPERATIVE TREATMENT. It is hardly necessary any longer to urge that the treatment of typhoid perforation is solely operative. It may not be always possible to operate, but when the diagnosis of perforation is once made one can no longer consider the patient as being under treatment if operation is not employed. So far as the patient is concerned, however, it can be safely said that operation should be resorted to in all instances. This is the only reasonable ground in even the most desperate cases. The list of recoveries contains a number of the most hopeless instances of surgery as a last resort, notably the remarkable case of Dr. Abbe, *New York Medical Record,* January 5, 1895, in which operation was performed sixty hours after perforation, and in which two pints of extravasated fecal matter were removed from the abdominal cavity; also the case of Dr. Champlin, No. 155 of Dr. Tinker's series, published by Dr. Keen in his article already mentioned, in which the interval between perforation and operation was estimated at three days; and the case of Dr. Pearson, *British Medical Journal,* 1899, vol. i. p. 1097, in which recovery followed operation nine days after perforation was thought to have occurred, although in this instance there was a localized abscess about the cæcum, the case resembling more a slowly progressing appendicitis.

The *time when the operation should be performed,* that is, the number of hours after perforation, is a matter upon which statistics seem strangely at variance with common sense and experience. Cases of perforation are always associated with a greater or less degree of shock. To operate during the severity of this condition can scarcely be considered wise unless the period of shock is unduly prolonged. The diagnosis having been made, however, the matter of an hour or two of heat and stimulation in the severest cases will serve to get the patient in as good condition for operation as one can hope. If the systemic shock is quite inconsiderable we need not delay even this length of time. If the period of shock is prolonged in spite of treatment, we believe that the danger of spreading infection will far exceed any possible benefit derived from delaying in the hope that the patient's condition will improve. It is owing to the deplorable lack of postmortem examinations that we are obliged to assume this position instead of accepting it from demonstrated facts. The cause of death in the vast majority of reported cases has not been accurately ascertained, and where stated has been merely a clinical assumption. The number of autopsies obtainable from the reports is far too small to justify any conclusions. It is probably true, however, that general peritonitis is the cause of death in the majority of fatal cases operated upon at an early date, and in a very large proportion of cases in which operation has been delayed. It must certainly be admitted that a case dying of general peritonitis following early operation could not possibly have been saved from this catastrophe by delaying a number of hours. The statistics of Dr. Westcott and Dr. Tinker, published by Dr. Keen, show that the largest percentage of recoveries follows operations performed during the second twelve hours after perforation. We cannot but feel, however, that these statistics, convincing as they first appear, are quite misleading. They are largely made up of the older cases, in most of which operation was long delayed and among which the recoveries were largely instances of fortuitous and unlooked-for good fortune. The fact, also, already mentioned, that the cause of death in all but a few of these cases was never definitely known affords a possibility of error that renders the statistics practically useless. In the more recent cases recovery has been much more frequent among those in which operation was early peformed. But even here, again, unless sufficient interest is exercised to demonstrate positively the cause of death in unsuccessful cases, the decision of this question must be largely a matter of general experience and not scientific demonstration.

The nature of the *anæsthetic* will often prove to be a matter of consequence, especially whether one will employ local or general anæsthesia. There are frequently serious objections to both, but we cannot at all subscribe to the feeling of certain writers who claim that local anæsthesia should be employed in all cases, and that the use of general anæsthesia is a deplorable mistake. By the employment of local anæsthesia it has been thought to obviate entirely the additional shock of the administration of a general anæsthetic. In some instances this is so, in others it is purely an assumption. It is too often the case that what may be spoken of as purely operative shock is largely attributed to the use of a general anæsthetic, and no one will maintain that laparotomy under cocaine, in which the abdominal contents are disturbed, is entirely relieved of shock by the omission of a general anæsthetic. The mental anxiety, worry, and dread incident to a laparotomy under local anæsthesia in a hardy, strong individual, or even in a patient whose sensibilities are dulled to no inconsiderable degree by the severity of the illness, is a consideration never to be overlooked and will not infrequently render the decision against local anæsthesia. What is to be accomplished is the greatest possible reduction of systemic shock to the patient incident to the operation, and in some instances this is best accomplished by local anæsthesia, in others by general anæsthesia. Stolid and more or less apathetic patients are more favorable for local anæsthesia. The amount of self-control an individual is able to maintain is a very uncertain indication, as the greatest self-control may sometimes be associated with extreme and very depressing mental strain. Even in those cases in which a local anæsthetic has been properly and successfully employed, it is doubtful if the extensive and careful abdominal irrigation usually required, can be as well accomplished in most instances without resorting to a general anæsthetic at this stage of the operation. As so much depends on the care and thoroughness of this part of the procedure, it does not seem always wise to complete it under local anæsthesia unless the indications are very direct.

One of the main objections to general anæsthesia is the fact that so much time is usually lost in getting the patient sufficiently under. This may be obviated by using chloroform after the administration of about one-quarter grain of morphine hypodermically; but what we feel will eventually prove a still more rapid and considerably safer method is the employment of nitrous oxide and oxygen followed by ether. By using the gas and ether alternately in getting the patient under, complete anæsthesia can be produced readily in one to two minutes, and the method is devoid of the unforeseen but ever-present dangers incident to chloroform. The prolonged use of nitrous oxide and oxygen alone may eventually displace the use of chloroform and ether altogether in these cases, but at the present time its usefulness and safety for prolonged anæsthesia has not been sufficiently demonstrated. When general anæsthesia is employed it is unnecessary to add that it should be given into the hands of one of very considerable experience, and the administration should be as light and as short as possible. One advantage of the general anæsthetic thus administered over local anæsthesia, which we feel is not always kept in mind, is the greater rapidity with which the operation can be done under general anæsthesia, and the considerable reduction of the exposure and handling of the patient, to say nothing of the added thoroughness with which the operation may be performed. The use of local anæsthesia in these cases is an extremely simple matter to one who has even a limited abdominal experience, but its usefulness and employment is something which should be carefully considered and not entirely assumed.

The requirements of operation are so direct and clear that the *technique* is simple, and the steps of the operation well defined and logical. As an operative procedure it has been so well developed that we can look for comparatively little improvement in this direction, and there is consequently much less of interest in this portion of the discussion. The *incision* in the right lower quadrant of the abdomen is the only logical opening in these cases, and the linea semilunaris opposite or a little above the anterior superior spine we believe to be preferable. The lower part of the ileum, the cæcum, and the appendix include the vast majority of perforations, and are, on the whole, most readily accessible through the incision mentioned. An additional advantage of this incision is the well-recognized fact that the search for perforation is best begun from the cæcum. The incision should be sufficiently generous, perhaps 8 to 10 cm. long, to allow a careful and somewhat visual exploration. It occasionally happens that the perforation is completely protected by well-formed adhesions and fecal extravasations prevented, as was the case in an operation performed by Dr. J. C. Warren, reported by Dr. R. B. Greenough, *Boston Medical and Surgical Journal*, May 8, 1902, vol. cxlvi. p. 491. If these adhesions are blindly broken up through a small incision unnecessary fecal extravasation may occur, the danger of which, owing to the certainty of the infection, cannot be estimated.

After entering the abdomen the first *search for the perforation* should be made in the ileum immediately above the cæcum, as the vast majority of perforations occur in this portion of the gut. By far the best way of accomplishing this is by starting at the cæcum, a fixed point very quickly found. We feel that this is a very wise routine procedure to employ, since one knows accurately the exact location of the small intestine he is handling and avoids the discouraging loss of time almost invariably incident to a haphazard and undiscriminating inspection of coils of small intestine appearing in the wound. Starting with the cæcum, one should inspect the ileum for a distance of about one metre. There is no object in going above this unless one intends to search the entire intestinal tract. This search for the perforation can be hurriedly but carefully conducted if the incision is sufficiently large to afford even a limited view of the general field. It is usually considered wise to replace the coils of intestine within the abdomen as the search is made, although some feel, and not without reason, that keeping the explored portion of the intestine well covered with hot towels and finally replacing all the coils at once can be accomplished with less handling of the intestines and less incident shock to the patient. We feel it is wise to make this first hurried search of the ileum for the perforation only, which is immediately recognized if present, a more careful examination of the gut for very thin ulcers being made after the really serious features are corrected, providing the condition of the patient will permit. It also affords a comprehensive conception of the portion of the bowel almost invariably affected, and prevents the possibility of spending valuable time over relatively unimportant conditions. It is, therefore, well to make this entire rapid inspection of the bowel even before closing any perforation that may be found. It is a very simple matter for an assistant to retain the location of these perforations outside the abdomen with sponges. The *method of closure of the perforation* is relatively unimportant, but should always be done with silk; catgut alone has been demonstrated on several occasions to be insufficient. A short double row of continuous Lembert sutures is all that is required, and can be very rapidly placed without elaboration. Excising the ulcer before suturing is an utterly useless and time-consuming procedure. It is a rare exception to find an ulcer of such size that the suture encroaches to an important degree upon the lumen of the gut; in such instances the suture must be placed with greater care. If there are several neighboring or confluent perforations, or the integrity of a considerable portion of the gut is severely impaired by deep ulcerations not yet perforated, it is wise to secure this portion of the intestine to the edge of the wound rather than consume time by resection or an elaborate method of suture, and to close the fistula subsequently. Having secured the perforation, if the condition of the patient permits, it is always wise to make a retrograde search of this last metre of the ileum for *deep ulcerations threatening perforation.* These can be recognized with considerable accuracy by the trained touch. Running the finger down over the bowel the dangerous areas are indicated by small, soft, circular places in the centre of a moderately large, thickened area. The sensation is readily acquired by post-mortem examination of an ulcerated ileum, in which the observation can be verified by subsequently opening the bowel. These areas when found should be reinforced by a running silk Lembert suture. The cæcum and appendix being immediately at hand, it is well to give them a passing inspection. One is scarcely justified, however, in removing the appendix unless it is seriously affected, and not in instances where it is "at all abnormal," as was recommended by Dr. Finney, in his article in the *Johns Hop-*

kins Hospital Reports. If no perforation has been found in the search so far instituted, it is inadvisable to make further examination of the intestinal tract, excepting, possibly, the sigmoid flexure, which is occasionally, though quite rarely, affected. Typhoid perforations in other locations are so extremely rare that one would lose many more patients in a prolonged intestinal search than in running the slight risk of having overlooked such a condition.

Irrigation of the abdominal cavity we feel should be somewhat prolonged and very thorough, even if there are no visible evidences of peritonitis or extravasation. The stimulating usefulness of hot irrigation has been even urged in explorations where no perforation has been found, but at the present time one hardly feels inclined to irrigate in such cases. In many instances this abdominal irrigation should be deferred until the inspection of the gut has been made, unless the inspection is seriously hindered by the amount or nature of the fluid present, in which case a rapid preliminary irrigation may be useful, the main irrigation, however, to be reserved until after the treatment of the bowel. Salt solution is possibly preferable to sterile water, but either one will do. It should be about 115° F., copious in amount. This, we feel, is best and most wisely accomplished through one or several irrigating tubes without removal of the intestines, and should be especially thorough in the region of the pelvis and lumbar fossæ. It is often well to irrigate the pelvis first, introducing a large rubber tube which will take up a large part of the return flow; in this way one will not infrequently avoid general dissemination of a large proportion of the abdominal fluid and fecal extravasation which very frequently settles to the pelvis. If extensive peritonitis is already present, one must treat this complicating incident as such, and that will vary greatly according to individual belief. We feel, however, that the extensive intestinal manipulation sometimes advised in such cases is of doubtful wisdom unless the condition of the patient is unusually favorable. We would feel inclined to rely on thorough and prolonged irrigation of the abdomen without removal of the intestines, as this is about all such patients can endure. In many instances, to properly accomplish this irrigation to the best advantage, we feel that a general anæsthetic is advisable, although it is occasionally satisfactorily accomplished under local anæsthesia.

It may seem occasionally wise to close these cases without *drainage*, but such has certainly been felt to be the rare exception. It is possible that having the temerity to close these cases after thorough irrigation may add considerably to the recovery rate; such cases, however, should certainly be restricted to those in which examination of the abdominal fluid during the operation shows the absence of organisms, or, possibly, those in which only bacilli are found to be present; but the advisability of drainage is scarcely questioned at the present time. The way in which one drains will vary according to the operator's personal belief. Whatever the method, however, it seems advisable to drain the pelvis. In the Lakeside cases what proved to be a very satisfactory method was by means of glass drainage tubes leading to the pelvis, and along the side of the tubes in some instances gauze drainage was also placed. It seems wise, also, to leave the seat of perforation or doubtful portions of the bowel near the incision, introducing gauze drainage to this portion of the bowel in order, if possible, to forestall the disastrous consequences of insecure suture or subsequent perforation. Around the drainage the wound should be closed as completely as possible, as the granulating capacity of such patients is sometimes considerably reduced, although the healing of wounds by first intention seems to be rapid and secure.

While it is needless to say that the operation should be done as rapidly as possible, it must still be remembered that *these patients bear operation* much better than one would ordinarily be led to suppose who had not had the opportunity for personal observation. The incision, the search for perforation, the repair of the bowel, can all be very rapidly and at the same time thoroughly performed, so that this portion of the operation may well be considered the minor part. The careful and thorough irrigation, however, is a matter that cannot be unduly hurried, although here the time can be somewhat diminished by having several irrigating tubes in use at the same time. This portion of the operation, while possibly consuming the most time, is the least depressing to the patient, as it is associated with a considerable degree of stimulation. We fear not a few cases are sacrificed through lack of proper irrigation, owing to the overwhelming desire of operators to complete the operation in as short a time as possible. We would urge the desirability of the utmost speed during the really operative part of the procedure, which is easily possible for any operator of moderate dexterity and good judgment, but would deprecate hurried and inadequate cleansing of the abdominal cavity. The superior ease and rapidity with which one can accomplish the operation under a general anæsthetic is often in marked contrast to the slow, painstaking procedure not infrequently required under local anæsthesia where the sensibilities of the patient are so keenly alive to what is going on, and this consideration, as previously mentioned, will not infrequently incline the operator to the use of general anæsthesia as of marked advantage.

The *subsequent treatment* of these cases presents nothing distinctive or striking, it only being necessary to keep in mind the requirements of the patient from the standpoint of a laparotomy on the one hand and that of typhoid infection on the other. While we do not mean to suggest that the treatment of such cases does not require the greatest care and judgment, it presents no distinctive feature which need be dwelt upon. One thing, however, is extremely desirable, namely, to keep constantly in mind the possibility of a subsequent perforation, and avoid as far as one is able the possibility of obscuring the manifestations of this occurrence in any way by the line of treatment.

The question of *exploratory incision* in rather doubtful cases of suspected perforation we feel is a matter of great importance and increasing interest. This has been most advantageously urged and considered by Dr. H. W. Cushing, and is, we feel, his most useful contribution to the surgery of these cases. It has been exceptionally well expressed in his article, "Sur la Laparotomie Exploratrice Précoce dans la Perforation Intestinale au cours de la Fièvre Typhoide," *Archives Générales de Médecine*, January, 1901. In instances where perforation is suspected, but the diagnosis cannot be considered as definitely made, exploration affords the only hope of avoiding the catastrophe of allowing a perforation to go unrecognized until more or less general infection has occurred. Even at the present time it has been proven beyond a reasonable question that these operations when properly performed are practically devoid of danger and affect the condition and course of the patient to a scarcely appreciable degree, whether performed under local or light and rapid general anæsthesia. If no perforation is found the abdomen can be immediately closed, a collodion dressing applied and the baths resumed within a few hours, so that treatment of the patient need scarcely be interrupted. Such was the case in No. 4 of the Lakeside series. The impervious dressing necessary for continued tubbing is conveniently applied by using six or eight alternate layers of collodion and sheet wadding, each layer being a little larger than the one previously applied. It is well to use only half of the thickness of the ordinary sheet wadding.

Exploration was first suggested by Dr. Finney, who advised making a very minute incision for the purpose of taking cultures from the abdominal cavity. This method was employed in the Lakeside case mentioned, but the restricted nature of this exploration was considered a mistake, and can certainly be no longer recommended. One must now be able to detect more than the presence of free abdominal fluid or organisms within the abdominal cavity. The perforation may be protected by adhesions or the ulceration may be scarcely through the peritoneum, either of which conditions may occur without being discovered by such restricted exploration. If one is to look at all he should examine the ileum and cæcum with care; it will take scarcely more time and will afford information of consequence. It must be readily admitted that the very slight danger incident to a rapid, skilful exploration is not to be compared with the serious consequences of an unrecognized perforation. Considering this as an aid to diagnosis, it is largely along this line that we are to look for a considerably larger percentage of recoveries from perforation. It will necessarily result occasionally in a premature operation, but will add very materially to the number of lives saved.

In instances where no perforation is found, either with or without evidences of peritoneal infection, at once arises the question of how far one may feel justified in exploring the abdomen for such *other intra-abdominal conditions* as have been known to suggest perforation. This is a matter which will be decided entirely by the individual judgment of the operator, and must be affected to a greater or less degree by the condition of the patient. Where, however, one finds an abnormal intra-abdominal condition, as peritonitis, for instance, it seems hardly justifiable to limit the search for the seat of the trouble to a rapid glance at the ileum and cæcum. The appendix is so close at hand that its inspection should never be omitted. The detection of suppurating mesenteric glands is important for the sake of adequate disposition of drainage. Exploration of the region of the gall-bladder may be accomplished without serious objection. The presence of intestinal obstruction may possibly be detected by a hurried examination of the intestine from several parts of the abdomen. Unless the indications are pretty direct, however, one would scarcely feel inclined to risk much time on this very remote possibility. The extent to which these explorations are to be pushed is a matter for much thoughtful consideration.

The advisability of *secondary operation* for subsequent perforation or other operative indications is no longer a matter of general question, but of individual judgment in each case. The remarkable vitality displayed in a number of reported cases in which two or more subsequent operations were performed, has established this point beyond reasonable question. Operative indications are to be followed, and can no longer be set aside, for the simple reason that the patient has already undergone one operation.

Prognosis. At the present time it is extremely difficult to form even a reasonable idea of the prognosis in these cases. We know that it is affected by a number of conditions. In general, the recovery rate is higher among young people. The time during the disease at which perforation occurs has an influence, since the recuperative powers of the individual are altered at different times. Recovery is less frequently to be expected when perforation occurs during the height and severity of the disease, whether of a primary attack or in the midst of a severe recurrence. When perforation occurs early in the disease, before the vitality of the patient has been drawn upon to any considerable degree, the prognosis in general is better, and also during convalescence after the recuperative powers of the individual have begun to assert an advantage. The prognosis is always severely affected, of course, by the length of time the case has been allowed to go after perforation, the extent to which a spreading abdominal infection has occurred, and the bacterial nature of this infection. It is also largely affected by the judgment, skill, and dexterity of the operator. But when it comes to an estimation of the percentage of recoveries the figures obtainable from the present statistics are, we believe, absolutely unreliable. In Dr. Westcott's table, comprising the first 83 cases reported, the recovery rate was 19.3 per cent., while in Dr. Tinker's table, comprising, presumably, the next 75 cases reported, the recovery rate was 28 per cent., making an average recovery rate for the entire 158 cases of 23.41 per cent. This recovery rate is far below that obtainable under the present conditions of diagnosis and operative technique; but the prognostic suggestions afforded by even the most recent cases which the writer has carefully collected are, we feel, too inaccurate and undiscriminating to deserve mention. This analysis affords a certain percentage of deaths associated with operation, to be sure, but many of the cases dying after operation bear no relation whatsoever to the true mortality in direct connection with either the perforation itself or the operation. This last statement has been most satisfactorily demonstrated by several post-mortem examinations in the Lakeside series. With but rare exceptions it has been impossible to draw this distinction in our study of recent cases owing to the incompleteness of the reports, but we are sure such a discrimination would alter materially our statistical mortality. Dr. Osler has divided these cases into three classes: those which recover from operation, those which die from causes immediately related to perforation and operation, and those which die from causes entirely unrelated to either. It is of the utmost importance that this distinction be kept closely in mind in forming an estimate of the mortality in these operations, but it is a distinction which, curiously enough, seems to have almost entirely escaped the thought of those attempting to form a statistical opinion of recovery and mortality. It is absolutely impossible to acquire the knowledge necessary to form this more accurate opinion without wide and accurate pathological observation and careful post-mortem examinations. An attempt was made by the writer to form such an estimate from the number of autopsies reported, but the number at present is so small and the reports are so fragmentary and inaccurate that the analysis has proved utterly worthless. Unless the operators under whose observation these cases are occurring can contribute generously to our pathological knowledge, any further reports are practically useless and might much better be omitted, since superficial reports only burden the literature without contributing to our present knowledge. Dr. Keen estimates that we can look forward to 30 per cent. of recoveries. The recovery rate at the Johns Hopkins Hospital of cases occurring while under treatment in the wards is 45.4 per cent. Dr. Osler estimated a possible recovery rate of 50 per cent., and Dr. Cushing of 50 to 60 per cent. We cannot but believe that a discriminating analysis in well-observed cases with complete pathological examinations would give a recovery rate considerably in excess of this, possibly 70 per cent.

PATHOLOGICAL CONSIDERATIONS. The *nature of the abdominal infection* in these cases is purely fortuitous, being drawn from the wealth of bacterial flora of the ileum, the possibilities of which have probably never yet been exhausted. The proportion of cases in which bacterial examination of the abdominal fluid has been made is very small, but such examinations have been more frequent in recent cases as their usefulness and prognostic value have become more evident. The infections as a rule, however, appear to be mild, largely bacillary, bacillus coli communis and bacillus mucosus capsulatus being the most frequent. One strange incident of a pure infection of staphylococcus pyogenes aureus has been reported. Some half-dozen cases of infection with bacillus typhosus have been collected, from which it appears that these cases are attended with a high mortality. It will be necessary, however, to have a large number of cases in which a complete and careful bacterial examination has been made to give these results anything more than a passing interest. It is very desirable that our knowledge of the nature of these infections be widely increased, as it may eventually be found that certain features in the treatment can be altered to advantage according to the nature of the infection. It is possible that certain infections which are recognizable from cover-slip examinations will require very much less thorough irrigation, for instance, and that in some cases we are at present subjecting the patient to a considerably more severe strain than the circumstances may require. Cover-slips and cultures should be freely taken, and as these procedures require but a moment they need scarcely interfere with the rapidity of the operation. These examinations should be made not only from the fluid first encountered on opening the abdomen, but also from the lower and more dependent levels, as it sometimes happens that the upper part of the abdominal fluid appears to be free from organisms, and one is led to the erroneous conclusion that no bacterial infection has occurred. It is very desirable, also, to make an examination from the site of the perforation itself, and this, of course, is especially necessary in early cases where no appreciable amount of abdominal fluid is present.

It has been thoroughly demonstrated pathologically, and in several instances has apparently been clinically confirmed, that *infection of* *the peritoneal cavity may occur through the base of an ulcer without perforation,* or even through the inflamed portion of the intestine itself without deep ulceration. Such a case was reported by Dr. Ioison, "Du Traitement du Chirurgie de la Péritonite Suppurèe Diffuse," *Revue de Chirurgie,* February 10, 1901, No. 2, where no solution in continuity of the bowel was found either at operation or autopsy. It is extremely probable, also, that such was the condition in the case of Dr. Dandridge, No. 28 of the Westcott series, in which no perforation was found, but the abdomen contained gas and free pus. The patient was irrigated and drained, and recovery followed. Such instances, however, are quite unusual, and it is hardly safe to assume that the case is of this variety, simply because no perforation is found in the rapid search of the ileum. It is, we feel, rather safer to assume that infection has occurred from some other source, which should be found and corrected as circumstances may permit.

It is probable that *adhesions* more or less extensive occur in all of these cases and that the infrequency with which they are reported is due to inaccurate observation necessitated by a very restricted incision through which the bowel has been drawn before the examination was made. As mentioned above, this procedure does not seem wise, since adhesions forming a perfect protection for the peritoneal cavity against infection may be blindly broken up and the opportunity offered for general infection. It is not meant in recommending a rather more generous incision that there is a necessity for actual visual observation of the entire field, but that by this means sufficient care can be exercised in the withdrawal of intestine to prevent fecal extravasation and infection where such has not yet occurred. In cases of what appear to be sudden perforation it is doubtful if these adhesions are of sufficient consequence to afford much protection. In the Lakeside cases, while no adhesions were found in those operated upon for perforation itself, it was probably true that they were overlooked through insufficient care in the search for the lesion.

With reference to the *great practical value of complete postmortem examinations* in these cases, too much cannot be said. The greatest interest thus far seems to have centred in reporting certain clinical features and the circumstances of recovery, and from the small number and paucity of the postmortem examinations it is evident that very little interest has been taken in this part of the subject. It is perfectly useless to continue reporting simple recoveries for the sake of apparently increasing the recovery rate. What is most essential at the present time is a large collection of well-observed and well-reported autopsies. A complete examination, however, does not necessarily mean a complete autopsy. Through even a restricted incision it is possible to gain a fairly accurate conception of the extent and nature of the peritoneal infection if present; the appearance of the bowel for the sake of comparison with that observed at operation; the presence of additional perforations, overlooked or subsequent, and the existence of threatening perforations; the degree of success with which the suturing has been accomplished, and other respects in which the operative technique has been unsuccessful. Cultures may also be widely taken through such an incision, and the spleen, heart, and lungs examined. Blood cultures should also be taken. It is only in this way that we are going to be able to arrive at some definite conclusions as to the cause of death in these cases and the respects in which the treatment has been unsuccessful, and it is only by these means that the mistakes that are constantly being made in every case of perforation, either in diagnosis or treatment, can be rectified. For the sake of the present patients the clinical features and the operation are of sole consequence; the interest of future patients, for the present at least, lies almost entirely in pathological examinations.

In the apparent hope of giving some general direction to the clinical features of these cases, Dr. Osler has published the specific instructions which are followed in the medical wards at the Johns Hopkins Hospital, "Perforation and Perforative Peritonitis in Typhoid Fever," *Philadelphia Medical Journal*, January 19, 1901, vol. vii. p. 116. This is as admirable a schedule as can well be imagined, and could most profitably be adopted for the sake of complete and uniform observation. To this schedule we would feel inclined, from an operative and pathological standpoint, to add certain suggestions which may be an aid in determining with more accuracy some of the unrecognized features mentioned in connection with these cases. Doubtful clinical features of so much consequence in establishing the all-important early diagnosis are covered by the Hopkins schedule. For the sake of a general and more accurate idea of the amount of systemic depression associated with the anæsthetic, the operation, or both, it is well to note with as minute accuracy as possible the condition of the patient immediately before and immediately following operation, as well as the changes in his condition for at least twenty-four hours subsequent to the operation. In taking cover-slips and cultures these should be obtained from various parts of the abdomen and also from the upper and lower portions of the abdominal fluid if present, and from the site of perforation. It is desirable to note with much care the general condition of the bowel, the nature and extent of adhesions, and the extent and severity of the general infection if present, for the sake of comparison with post-mortem examination in case the patient does not recover. In the post-mortem examinations, whether complete or restricted, the condition of the bowel and the extent of infection should be carefully noted; cover-slips and cultures should be widely taken from the abdomen, organs, and blood; the condition of the operative field in the bowel should be carefully observed, also the presence of additional perforations, either those overlooked during the operation or those apparently subsequent to the operation, and the presence of threatening perforations. These are all points of special consequence, which, it is believed, will lead to an accumulation of facts of much practical value if carefully and generally observed. It is necessary to make so many of these post-mortem examinations without the direction of a trained pathologist that the circumstance seems to justify the mention of these details. It is from well-equipped hospitals that we must first look for such a class of reports, as elsewhere it is scarcely possible to have both medical and surgical observation of all typhoid cases, and especially of all suspicious cases. A means which will add very materially to the unity and usefulness of these observations and reports, and which will tend to develop a degree of judgment in diagnosis and operation that cannot possibly be obtained in any other way, may be afforded by having all these cases brought under the immediate control of one member of the hospital staff. The number of perforations occurring during a year in any one institution is not large, and if the opportunities for observation and treatment are divided among a number of men the experience gained by each is very limited, the observations are very apt to be restricted and unmethodical, and the combined judgment rather biased and uncertain according to the nature of the particular case or two which has come to the hand of any one man. We feel that if this suggestion could be carried out our knowledge of this subject would be widely, rapidly, and very beneficially increased.

While, however, it is true that a large portion of these operations will still be done in hospitals, mainly on account of the difficulties in diagnosis, it is still interesting to note that there has been reported by a general practitioner one successful case in a country house under the conditions which one finds there ordinarily existent. The case was reported by Dr. R. T. Davis, "Perforation in Typhoid Fever; Operation; Recovery," *American Medicine*, January 18, 1902, vol. iii. p. 116. The operation was performed only six hours after perforation was thought to have occurred, which betokens a degree of watchfulness that one can scarcely hope to obtain with much frequency under such conditions. As this is the first case of its kind reported it is of special interest in showing the changing attitude of the medical profession in general with reference to perforation during the course of typhoid fever.